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System Design for NMP and NPDES Permit Application for the U.S. Meat Animal Research Center

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Abstract. All concentrated animal feeding operations that have the potential to discharge are required to apply for a National Pollutant Discharge Elimination System (NPDES) permit. The process also requires development of a nutrient management plan (NMP). Recent actions by the U.S. Environmental Protection Agency have indicated that alternative control technology (ACT) could be used if the ACT was shown to provide equivalent or superior environmental protection compared to traditional facilities designed to meet zero discharge from a 25-yr, 24-hr design storm. In addition to manure handling systems contained in the plan, a NMP is required to detail how both liquid and solids from animal feeding operations will be used, together with commercial fertilization on cropland. This paper will outline the procedure, design considerations, and the resulting NPDES permit application for the U.S. Meat Animal Research Center at Clay Center, Nebraska.

Keywords. Livestock waste, alternative control technology, Feedlot runoff

Introduction

The U.S. Meat Animal Research Center (USMARC) is located in Clay County, NE (fig. 1) and includes a 4,300 head beef cattle feedlot, a 3,000 head sheep feedlot, farrows 720 litters of pigs per year, and has lesser populated beef barns, a remote sheep feeding area, and a common solids storage area. Since the entire operation (12 independent systems) was under the control of USMARC, a National Pollutant Discharge Elimination System (NPDES) permit was required, along with a Nutrient Management Plan (NMP), to be issued by the State of Nebraska, Department of Environmental Quality (NDEQ). As the Biological Engineering Research Unit (BERU) was conducting research on nutrient management issues and had been working on a simplified feedlot runoff control system, members of the research unit agreed to develop the necessary waste management system design and submit an application to construct a precipitation runoff control system for each livestock feeding area. The objective of this paper is to present design criteria of the research sites (7 of 12), along with other system designs and management plans to complete the permit application.

Retrospect

The USMARC has been in compliance with NDEQ since its inception. As livestock production facilities were completed, control of precipitation runoff or treatment of housed confinement manures have been a priority. The USMARC cattle feedlot was an early example with a precipitation runoff system designed and constructed to contain the 10-yr, 24-hr storm, part of the earliest Nebraska standard. The system, described by Nienaber et al. (1974), was constructed in 1971 to serve south sloping pens and has been in continuous operation since that time (fig. 2; 43A Ponds). The system includes a sedimentation basin which drains into the original holding pond, and then is connected to a second holding pond constructed in 1985. The sedimentation basin is cleaned on approximately 5-year intervals. The first holding pond was cleaned after 30 years of operation, with about 1.3 m of solids accumulation in the 3.4 m deep pond. Liquid from the holding ponds is distributed to an adjacent surface irrigated corn field, which has a tailwater recovery pump. All runoff is returned to gated pipe used to irrigate the cornfield.

A second runoff system serves the west end of the south sloping pens of the feedlot and the feed storage bunker silos, animal handling facilities, and ration preparation area (fig. 2; 43D Ponds). The runoff control system, built in 1994, was designed according to NDEQ specifications to control precipitation runoff from affected areas.

A passive runoff control system with a vegetative treatment area, now referred to as Alternative Control Technology (ACT), was constructed in 1998 as described by Woodbury et al., 2002. The system was installed on a portion of the north sloping pens to study the effectiveness of controlling feedlot runoff without long-term liquid storage or distribution pumps (fig. 2; 408-415 VTA). Evaluation of that system effectiveness has been shown to be sustainable with respect to both water and nutrients (Woodbury et al., 2005).

In addition to the cattle feedlot, four housed confinement barns were constructed in Area 25 (fig. 3) for intensive animal research studies. Runoff from those barns was directed to the sanitary treatment system, which consists of 25 hectares of lagoons. A pit flushing system which incorporated solids settling basins and holding/recycling ponds was developed in the 1970's to serve three additional cattle barns for finish feeding programs.

The USMARC sheep feedlot consists of seven deep-bedded barns with outdoor penning. Runoff from the area is dispersed to nearby grass land.

The USMARC swine area, also developed in the 1970's, is serviced by a fresh water flush system consisting of a common buried drain line, which collects flushed manure from 14 barns that is controlled by a lift station and four interconnected lagoons. Flushed material is pumped to the highest elevation pond, which then is manually drained through lower elevation cells on a nearly daily basis. The lowest pond elevation is maintained by pumping liquid to a large, common storage pond used to accumulate liquid from both the housed beef and swine areas. Liquid from that combined holding pond is distributed to adjacent sheep pastures as needed, according to pasture nutrient requirements.

During the 35-year period from early livestock feeding operations development to the present, USMARC has maintained contact with the NDEQ for both livestock and sanitary waste treatment and control, including annual or semi-annual inspections by NDEQ Field Investigators. In addition to the controls in place at various feeding facilities, the USMARC includes a large cropland base on which to utilize all manures generated by its livestock feeding operations. There is a cropland and grassland buffer of ten kilometers from point of origin (feedlot) to point of discharge from USMARC property, with no flowing streams; however, there is a lesser distance (.7 km) from the north of the feedlot to an adjacent wetland that is buffered by grass. During wet years, standing water in the wetland approaches the USMARC pasture northwest of the feedlot.

In 2003, the action of the U.S. Environmental Protection Agency (EPA) required that all Concentrated Animal Feeding Operations (CAFOs) have a NPDES permit, regardless of pollution potential. Coincident with this action, EPA also ruled that ACT could be utilized by CAFOs to control runoff, providing that the CAFO could demonstrate the alternative method was equivalent to or better than the standard system outlined by Effluent Limitation Guidelines (ELG). Given that we had been conducting research on the performance of a simplified runoff control facility with grass utilization of runoff (vegetative treatment system), the stage was set to include these types of facilities in an approved NPDES permit.

Alternative Control Technology

As a consequence of the EPA ruling on potential use of ACT for CAFOs, an informational meeting among regulators, researchers/extension educators, facility designers, producers, and environmentalists was held in Ames, IA, sponsored by the Iowa Cattlemen's Association. As a result, a working group was formed of parties from each interest area to develop guidelines for alternative control technologies under sponsorship of the Natural Resource Conservation Service. In July, 2004, a preliminary report of that working group was presented, along with model results that predicted the performance of both ACT and ELG systems (Koelliker et al., 1975; Wulf et al., 2003; Lorimor et al., 2003). Action of that working group also adopted the Vegetative Treatment Area (VTA) terminology to describe the use of vegetation to manage the outflow from the open lot facilities. The guidelines developed by the working group included siting, design, and management of ACT (NRCS, 2005). A summary of this development process was presented (Koelsch et al., 2005), and review of ACT-type structures on non-CAFOs was recently presented (Koelsch et al., 2006). Submission of this permit application to NDEQ was the first such test of acceptance of the alternative control technology for CAFOs in Nebraska. Smaller animal feeding operations had been approved for use of these types of design. Acceptance of design adequacy was based on demonstrated equivalent or better performance using the models of Wulf et al., 2003 and Koelliker et al., 1975.

Livestock Waste Management Plan

The NDEQ requires an approved construction permit before any work is initiated on a runoff control facility. Twenty-two items were included under seven general sections to complete the permit application. Not all details will be included, but all items and sections will be presented.

Section 1: *Item 1*, the Application Fee; *Item 2*, the Application Form; *Item 3*, Operational Information (part of the application); *Item 4*, Disclosure Information; and *Item 5*, Approval from Department of Natural Resources if dam safety is an issue (not needed here).

Section 2: *Item 6*, Descriptive Project Narrative. This item is designed to provide a clear description of all the facilities that require runoff control or manure management. These descriptions will be included in the subsequent items 7 through 11.

Item 7. Site Location Map. An overall USMARC location map is shown in figure 1, with a feedlot map (primary cattle finish feeding area) and Area 25 map (cattle, sheep, and swine housed confinement) in figures 2 and 3, respectively. The details in figure 1 show the layout of the feedlot, the office laboratory complex and the Area 25 sheep, beef, and swine housed confinement areas with respect to the USMARC boundaries along with neighboring communities and farmsteads. A 610 m (2000 ft) facility offset line is required around each of the livestock feeding facilities as shown in figures 2 and 3. Only one residence is located within this range, and that is for a remote sheep feeding area (Pole Shed 1; figure 3). Clay Center is the nearest community, and is located approximately 6 km (4.5 miles) east of the Area 25 confinement barns. Surface drainage from all the production facilities is to the southeast direction, except for a small portion of the feedlot which drains to the north as indicated earlier. Drainage from the southern sloping pens of the feedlot exits USMARC approximately 10 km from the origin, and drainage from the Area 25 housed feeding facilities is approximately 5 km, all of which is pasture land. Land use between the feedlot and Area 25 is primarily corn and alfalfa production. Groundwater wells are also indicated on the site maps. Two domestic wells at the feedlot and three irrigation wells are located within the 610 m offset. Three domestic wells are located within the 610 m offset of the Area 25 sites, however, each of these wells is located upgradient from the feeding facilities. All domestic wells have been monitored for water quality (nitrate and coliforms) since the facilities were first developed. Numerous irrigation wells are located within the offset lines of the Area 25 facilities, but none are located outside the USMARC boundary.

Item 8. Topographic maps. Figures 4 and 5 show the general topography of both feeding areas to be of gentle slope. The drainage path for all surface runoff from both sites is clearly evident, and divides the housed confinement (Area 25) for sheep, beef, and swine. Proximity to this drainway is the primary reason that traditional ELG systems were designed for each of the housed confinement systems. Topography is a critical element for successful utilization of alternative control technology.

Item 9. Scaled Site Drawing. Detailed site drawings of each of the sites is required here, but will be included in the next portion of the paper for the ACT systems only.

Section 3: Livestock Waste Control Facility (LWCF) Design Data.

Item 10. LWCF Plans and *Item 11*, Sizing and Design. These will be presented by facility type, with the seven ACT research site designs presented first, then the ELG plans.

301-316 VTA & 416-420 VTA

These 2.6 and 2.1 ha feedlot areas, respectively, are controlled by ACT basins, with VTAs shown in figures 6 and 7. The settling basins each were designed to contain the runoff from a 25-yr, 24-hr storm (9.9 cm/ha; 3.9 in/ac), plus .45 m freeboard (1.5 ft). In addition, the 416-420 VTA has capacity for 13 mm (0.5 in) solids accumulation per unit area of the feedlot. The primary solids accumulation area for the 301-316 VTA is just outside the feedlot pens up slope from the basin. The basins were designed to drain in approximately 72 hr following the occurrence of the design storm. Two discharge 200 mm (8 in) PVC outlets were located on either end of the basins, away from expected solids accumulation areas. The outlets were perforated to restrict discharge to the desired rate. Discharge will be directed to gated irrigation pipe to distribute the liquid across the width of the VTA. Gates will be opened to distribute the liquid at an estimated rate of 40 l/m (10 gpm). A total of 15 and 13 open gates are estimated for the 301-316 VTA and 416-420 VTA, respectively. A summary of attributes of each ACT and VTA system is presented in Table 1.

Slope of each VTA is 0.5%, and each of the VTA fields will be seeded primarily to brome grass. Grass will be seeded in perpendicular rows to the basin to facilitate flow down the length of the field. Each VTA was sized to provide twice the area of grass per area of feedlot due to the limitation of soil infiltration rate (13 mm/h; .5 in/hr). Configuration of the 301-316 VTA was 162 x 310 m (530' x 1020'). Configuration of the 416-420 VTA was 185 x 225 m (743' x 606'). This resulted in open gate spacings of 10 and 18 m (35 and 60 ft), respectively, for the 301-316 VTA and 416-420 VTA. Operation of the system will be such that spacings and flow rates can be increased or decreased to improve the distribution of the nutrients across the VTA. Open gates will be alternated to achieve uniform nutrient loading across the VTA as evaluated by electromagnetic induction.

Electromagnetic induction (EMI) has been utilized to evaluate the distribution of soil electrical conductivity (EC_a) within a field (Woodbury et al., 2005). Each VTA will be surveyed with the EMI instrument initially, then on an annual basis to evaluate the effectiveness of the design in distributing nutrients across the field. The EMI has also been used to determine the length of movement of nutrients down the length of the field. In order to be assured that no discharge of liquid from the VTA would occur from a design storm, a .45 m (1.5') soil berm will be formed around the side and down slope boundaries. The EMI should also provide evidence of ponding at the lower end of the VTA if it occurs.

Management of all VTAs will include minimizing all vehicular traffic to harvest and weed control on dry soil. No animal traffic is planned under any conditions, with all hay removed from the site to provide nutrient removal. When establishing the grass and during extended dry periods, weed control may be an issue and must be managed to provide the planned nutrient uptake and removal from the site.

404-407 VTA & 408-415 VTA

Basin 408-415 VTA was the original passive runoff control system described by Woodbury et al., 2002 (fig. 7). Basin 404-407 VTA is physically adjacent to the original system, and of a slightly larger area/area of feedlot 1.8 vs 2.0 to accommodate more recent design estimates (fig. 7). These 2.4 and 1.1 ha feedlot areas, respectively, are controlled by ACT basins with VTAs. The settling basins each were designed to contain a minimal amount of runoff (30 mm/ha; 1.2 in/Ac), with no additional capacity for solids accumulation, freeboard, or rainfall on the basin itself. Retention time within the basin was designed for a maximum of 2 hr. Where the original basin provided .3 m (1') of solids storage below discharge pipes, these basins have been constructed to drain completely after each runoff event. PVC elbows (200 mm; 8 in), with 33

mm holes, were placed at the bottom elevation of the basin to provide liquid detention. The elbows, with PVC pipe extensions to .5m total height, were spaced at 21 m (70') across the length of the basin. Basin lengths were 127 m and 274 m (420 and 900 ft), respectively, for the 404-407 VTA & 408-415 VTA. Basin width was designed at 3 m (10'), with a 6:1 slope entrance into the basin.

The original basin was difficult to clean with a front end loader, leaving substantial cuts below the original bottom to be back-filled after cleaning. Therefore, the basin was filled with an average of 0.45 m (1.5') of pond ash material to facilitate support of cleaning equipment. Pond ash is the fly ash byproduct generated by a coal-fired electrical power plant, which has been flushed to a storage pond and subsequently removed after draining the pond. Although the pozzolanic properties of the fly ash are absent in the pond ash, it has been shown to provide excellent material for use within high-traffic areas of a feedyard, and provides support for cattle (personal contact, Kirby Knight). We have used the material within the feedyard both under roof and in an open lot, and it has remained stable over a 2-yr period. We also used a .3 m (1') thick layer of the material as a test section in the basin and found it to be stable to a point, but repeated loader passes and turning caused the test plot to give way, therefore, we increased the base to .45 m for further evaluation.

Runoff exiting the settling basin is directly released to the VTA through the large diameter pipes (200 mm; 8 in). It is less controlled for uniform distribution, but also requires less management. Grass will be seeded in parallel rows to the basin to facilitate spreading across the width of the VTA. We have noted some build-up of nitrate near the discharge pipes, but it remains to be seen if this becomes an important management issue. We have replicated the 408-415 VTA to provide additional evidence of this low management technique.

1100 VTA

This .65 ha feedlot site is controlled by an ACT basin with a VTA (fig. 8). This is a high visibility location at the entrance of the feedlot. It is also bounded by a road, and the VTA has a road along two sides. Therefore, settling basin capacity was increased to reduce the possibility of an overflow. The basin was designed to contain the runoff from a 25-yr, 24-hr storm (9.9 cm/ha; 3.9 in/ac), plus 46 cm freeboard (1.5 ft), plus 13 mm/ha solids accumulation, plus 125 mm (5") for rainfall directly on the basin. Five PVC pipes (100 mm; 4"), evenly spaced across the 115 m (375') width, will be restricted to discharge the design storm in 72 hr (150 l/m; 40 gpm). The PVC pipes pass under the road to the VTA.

Grass will be seeded in parallel rows to the basin to facilitate distribution of the discharge across the width of the VTA. Like the previous sites, a ratio of 2:1, VTA to feedlot surface, will be used, and a soil berm will be placed around three boundaries of the field to prevent any overflow from a design storm. Vegetative treatment area dimensions were 115 x 115 m (375' x 375'), and are formed by one corner of a center pivot irrigation system, not part of the ACT.

This basin area is large compared to others, and we have designed .45 m of pond ash to be used in the bottom to provide a solid base for cleaning equipment. Similar to the large basins on 301-316 VTA & 416-420 VTA, we plan to remove solids with a box scraper and light-weight tractor instead of the loader used in the narrow basins. This combination of basin designs will provide various basin bottom widths and base materials for comparison in solids removal. Since none of the basins are designed for long-term storage of liquids, percolation rates are not an issue, and the basins do not require a liner, although the clay soils have a low permeability.

Pole Shed 1 and Area 25 Solids Storage

These 1.3 and 0.7 ha sites are somewhat non-traditional and well suited to the settling bench concept for solids removal. No basin will be formed for either system which uses VTAs of design area ratios of 1.4 and 2.0, VTA:Feedlot. Pole Shed 1 (fig. 9) is a sheep feeding area that combines outdoor feeding and limited shelter for sheep, and is used much of the year, thereby requiring runoff control. The Area 25 Solids Storage (fig. 10) is an accumulation point for manures and waste feed collected from beef, sheep, and swine facilities in Area 25. These solids are applied to cropland when conditions are appropriate, and may be stock piled for several months. Both sites have been operated as settling benches without any particular design. The only modification will be to form a 6 m (20') level area to accumulate solids before discharging to the respective grassed areas. Each of the VTAs has a 0.5% slope, and will be seeded parallel to the bench area to facilitate spreading across the VTA. As in the other VTAs, the boundaries will be surrounded with a .45 m (1.5') soil berm to contain any potential discharge caused by the design storm.

There are four traditional waste control facilities involved with this permit application, and these will be presented without much detail. Table 2 summarizes the design criteria of each of these solids settling basin/holding pond combinations. Land application of the liquids will be described separately.

Area 43 A

This 17 ha feedlot site controls the runoff from the major portion of the south sloping feedlot pens. As indicated in the description earlier, this is the original site which was updated in 1985, but remains substantially below NDEQ volume standards because no provision had been made for June runoff or freeboard in the original design. The combined holding pond volume will include a provision for the addition of all runoff from the 1100 VTA system in the advent of a requirement to modify that system in the future. A small area of pens at the crest of the feedlot was added to this system. The resulting changes will bring the combined volume to 99 mm (3.9"), plus 53 mm (2.1") for the average annual June runoff, plus 13 (.5") mm for solids storage, all based per ha of feedlot area. In addition, storage for the design storm rainfall, 127 mm (5.0") on the pond itself and 0.45 m (1.5') freeboard, approximately doubles the existing system storage volume.

Liquid distribution of the runoff within the holding ponds will be by gravity irrigation to an adjacent alfalfa field. As indicated earlier, this field is serviced by a tailwater recovery system that returns all runoff from irrigation or holding pond application to the gated pipeline.

The solids settling basin will continue to serve the entire system and will be cleaned as required, which has been on an approximate 5-yr interval. All solids removed will either be stockpiled on the designated site, or land applied according to the Nutrient Management Plan.

Area 43 D

This 4.9 ha site is made up of sick pens, feed preparation area, and office complex, and the bunker silage storage areas. In addition, there is approximately 1.2 ha of contributing area to be used as the solids storage area for the feedlot operation. Feedlot pens are cleaned throughout the year, although the primary cleaning operation occurs during the summer months after most of the cattle are marketed and before the spring calves are weaned. There is a need for temporary storage, so that the accumulated solids can be judiciously applied to cropland, which generally occurs after harvest. As indicated, this system was constructed in 1994 according to NDEQ standards, and is similar to the storage volumes to be provided for Area 43 A.

The liquid distribution of runoff will be to the same alfalfa field available to the Area 43 A system, but not overlapping. Solids accumulation has been minimal in the past 10 years of operation. The system contains two cells, one designed for solids removal as needed.

Area 25 – Beef

This 4.8 ha area consists of three beef feeding barns with outdoor penning, an animal handling facility with small loafing pen, and a bunker silo. The current flush system will be removed along with the solids settling pits. The storage ponds used for holding recycling water for the flush system is of adequate size to serve as the holding pond for this ELG. Total volume of the two adjacent holding ponds will provide the same storage volumes outlined in the Area 43 A system, with an additional freeboard which totals 1.3 m (4'). A 335 m (1100') long solids settling basin will collect runoff from the combined area and direct liquid to the holding ponds. Liquid in the holding ponds will be pumped to a common holding pond serving all Area 25 feeding facilities (cattle, sheep, and swine).

Area 25 – Sheep

This 5.6 ha area consists of seven deep-bedded barns with outdoor penning. All stormwater runoff from the area will be directed to an ELG designed system including adjacent solids settling basin and holding pond. There is a long history (35 years) of operation with most of these facilities, which have a very low solids content in the runoff liquid. For this reason, the solids load on the settling basin was reduced to 6.5 mm/ha (.25 in/ac). Other storage volumes were provided according to NDEQ standards for the combined solids settling basin/holding pond. Liquid from the holding pond will be pumped to the adjacent common holding pond serving all Area 25 feeding facilities.

Area 25 – Swine

This 14 barn fresh water flush system feeding facility, with four holding pond/treatment lagoons, was designed according to NDEQ standards and approved in 1991. No changes in operation are anticipated. Liquid from the combined four ponds will be managed by daily pumping liquid to the common holding pond serving all Area 25 feeding facilities.

Area 25 Common Holding Pond

This 0.123 million m³ (4.36 million ft³) pond system (two adjacent ponds) is designed to accumulate liquid from the Area 25 livestock production facilities. This mixture of sheep and beef area precipitation runoff and swine area flushed water is used to apply to adjacent sheep pastures, according to the nutrient requirements of the grass. The pasture is divided into 16 – 4.1 ha (10 Ac) paddocks for grazing or isolation during liquid application. Nutrient content of the liquid and soil nutrient content will be used to determine the rate of maximum application, otherwise water requirements of the grass will determine application amounts. A high pressure traveling sprinkler irrigator will be used to distribute liquids.

Item 12. Supporting site data

This section includes depths to groundwater, soils lab tests, and suitability of soil to use as a liner material. Since each of the proposed holding ponds are adjacent to existing ponds in use for over 10 years without seepage problems, we utilized the geotechnical report developed for construction of the sanitary lagoon expansion in 1988. The site was on the same type of soils (Hastings silt loam), and is physically located within 1 km of the lagoon site. In addition to soils classification data, measurements of soil permeability were reported. Depth to groundwater across all 12 sites ranged from 25 to 27.5 m (85 to 90 ft).

Item 13. Liner Design

The geotechnical engineer recommended use of the soils as a liner for the holding ponds:

- 1) After the area of the pond is graded to the elevation designated at the base, excavate .3 m (12") of surface soil and stockpile.
- 2) Loosen the exposed layer with appropriate disking equipment.
- 3) Adjust moisture content of the soil to within +4% and -2% optimum. Compact to a dry density of at least 95% of maximum dry density of soils per ASTM D-698.
- 4) Spread .15 m (6") of stockpiled soil and repeat steps 2 and 3 for this layer.
- 5) Spread remaining stockpiled soil and repeat steps 2 and 3 and grade to finish elevation.
- 6) Interior sides of the holding pond should receive the same compaction treatment as the base.

Section 4: Construction Quality Assurance Plan

Item 14. Construction Quality Assurance

This plan details the responsibility of the Project Engineer for accuracy of all facets of the construction process, officially naming the Project Engineer as representative for the owner in construction activities. It defines that dimensioned drawings have precedence over general drawings where discrepancies exist.

The Project Engineer has authority over all testing procedures, site inspections, and stakes out the construction of all facilities. Components to be inspected include Core Trench, Holding Pond Liner; and Holding Pond Inlet and Staff Gages. All subgrades and fill layers must be inspected immediately prior to further construction. When construction is finished, the site will be measured by the Engineer to ensure it was constructed as planned.

The construction shall meet the specifications of the report. The Engineer will determine if the berms are constructed according to specifications. The constructed liner shall have a maximum seepage rate no greater than 0.125 inch per day (3.18 mm). Upon completion of the pond, one floor sample and one sidewall sample shall be taken. The samples shall have a minimum depth of six inches (15 mm) and tested for permeability. Tests shall be acceptable if no greater than .125 inch per day (3.18 mm) using Darcy's Law based on maximum design head, liner thickness, and saturated hydraulic conductivity. If unsatisfactory tests are obtained, the seal must be reworked and additional tests performed until an adequate seal is obtained. All sample locations will be documented on the test report.

A final certification and report will be conducted by the Engineer to ensure that the facility is within 5% of dimensions, and that the liner was constructed according to specifications.

Section 5. Operational and Maintenance Plan

Item 15. Operational and maintenance information includes all of the following for each site.

- A. Pumping equipment for holding ponds with storage tables and operational levels related to a depth marker or staff gauge. All markers shall include Freeboard level, must-pump level, winter pump-down level, and minimum treatment volume.
- B. Solids handling requirements, scheduled cleaning of settling basins, and solids storage area operations.
- C. Pumping equipment, necessary capacity, land area, irrigation distribution system, method of land application of liquids or slurries, and planned disposal periods.
- D. Maintenance of any equipment or solid settling components of earthen structures and erosion control.
- E. Control of vegetation weeds, trees, grass cover to prevent erosion, mowing and weed control.

Section 6: Nutrient Management Plan

Item 16. A trained planner was required to submit this section, which details sampling and analysis of manure sources and fields to be used for application, along with yield projections.

- A. Soil sampling methods and analytic methods for soils and waste.
- B. Means to determine application rates.
- C. Application schedules on a three-year rotation.
- D. Field information (legal description, landowners, crops, yields, solids or liquids, application method, wetlands, buffers or set-backs, location of waters of the state). Maps must show surface water within 200 ft (60 m) of all application sites.
- E. Record keeping of soil testing, waste analysis, application locations, and amounts. Records must be maintained for five years.

Item 17. Mortality Plan

All animal deaths are reported to the USMARC veterinarian, Dr. Shuna Jones. Disposition depends on the size and species. All records of necropsy are maintained by the species managers. The USMARC burial plan was approved and is maintained according to NDEQ regulations, with records of all dates of burial and estimated weights.

Horses: All horse carcasses are buried on USMARC premises.

Cattle: All cattle are necropsied at the laboratory, picked up by S&S By Products of Hastings, NE and transferred to Lexington where they are processed by Nebraska By Products. Any cattle too autolized are taken to the USMARC burial site.

Swine: All stillborn piglets are incinerated in an approved facility within the Swine Area. All older animals are necropsied and picked up by S&S By Products.

Sheep: All sheep fatalities are necropsied and buried at the USMARC burial site.

Ground meat samples: All ground meat samples are taken to the USMARC burial site.

Item 18. Chemical Management Plan

This section requires a detailed map of the location of all stored chemicals (insecticides, herbicides, or other pesticides or disinfectants) adjacent to feeding operations, including chemicals used for farming practices. The section also requires the storage location of all petroleum products, fuels, lubricants or oils, used oil or antifreeze adjacent to animal feeding operations.

Item 19: Emergency Response Plan

An emergency response plan is required to deal with all situations where lagoons, holding ponds, or berms are breached, or a breach is eminent due to equipment failure, storm size, or extended wet periods. In addition to actions to be taken, a list of USMARC supervisors responsible for the area and NDEQ notification is available, along with phone numbers.

The Emergency Response Plan is posted on employee bulletin boards, next to all animal feeding operations phones, and in the Nutrient Management Plan file folder.

Item 20. Best Management Practices for Odor

- A. Pens will be maintained and kept as clean as possible. Pens and basins will be cleaned at least once each year, and manure applied to crop land according to agronomic rates. Holding pond liquid will be applied as outlined.
- B. Odor Source Emissions. Potential odor sources are identified and a management strategy was developed for each source.
- C. Odor Transmission and Impact. Nearest communities are Clay Center, located four miles to the east; Harvard, six miles to the northeast; Fairfield, six miles to the southeast; Glenvil, eight miles to the southwest; and Hastings, 11 miles to the northwest. Other properties immediately surrounding USMARC are primarily rural properties, and no major odor nuisances are anticipated.
- D. Odor Monitoring and Surveillance. Any odor complaints reported to the operator will be recorded, with notations concerning unusual conditions or operational aspects such as disposal activities.
- E. It is the intent to employ prudent management practices that will control/reduce odors. In addition, an active odor control research project is in place to investigate or develop improved methods of odor control.
- F. The operator will review this plan annually, and new technologies will be reviewed and implemented where appropriate.

Section 7: Closure Plan and Records

Item 21. Facility Closure Plan

- A. NDEQ will be notified in writing within 30 calendar days of cessation of operation of the facility and any animal waste retention structure.
- B. The plan includes the following: 1. Dewatering Method; 2. Sludge/Sediment Handling; 3. Analysis of Sludge/Solids; 4 Disposal Method/Location.
- C. The closure will commence within six months, and be completed within one year of cessation of operations unless approved by NDEQ.
- D. Additional reviews of facilities will be made at the time of cessation.
- E. Any exemption from these closure responsibilities will be requested in writing for approval by the NDEQ.

Item 22. Record Keeping/Inspections/Monitoring

The following items are required under this item. Records of equipment and facilities inspections, including weekly inspections and records of the depth of manure and process wastewater, as indicated by the depth marker.

Records to document any actions taken to correct deficiencies; records of mortalities, chemical management, and related practices; the completed permit application, including records that

document adequate storage capacity; the nutrient management plan, including test methods used to analyze manure, process wastewater and soil; the date, time, and estimated volume of any overflow or discharge; expected crop yields for land application areas; the date that manure or process wastewater was applied to each field; weather conditions at the time of application and for 24 hours prior to and following application; results from manure, process wastewater, irrigation water, and soil sampling and testing; explanation of method used to determine application rates; results of the most recent phosphorus risk assessment for each field; calculations that show total nitrogen and phosphorus to be applied to each field; the method used to apply the manure or process wastewater; dates of inspections of equipment used to apply manure or process wastewater.

Item 23. Ground Water Monitoring

The NDEQ will determine the need for groundwater monitoring, based on review of each application. If required, the plan will be a stand-alone document, not to be included in the construction approval or NPDES application.

Conclusion

An early lesson in this process was that NDEQ does not allow construction without an approved permit. Although USMARC had no intentions of populating a new facility, VTA 1100, the pens were built and a basin constructed prior to construction of a research building so that grant funds could be utilized. A NDEQ Notice of Violation was issued but resolved as an oversight by USMARC with no intention to violate any statutes. In fact, construction of a borrow-pit is permissible, but we had installed drains in that pit and it looked like a finished product when it was not. The saying "If it looks like a duck, etc." applies.

The completed permit application was presented to the Nebraska Department of Environmental Quality on September 30, 2005. The permit application was approved on January 20, 2006 after the Department review and a 30-day public notice period. There were no comments or challenges to construction of the facilities. However, this was not sufficient to begin construction. A separate Construction Approval request was needed to allow USMARC to begin the construction phase. Included in this approval request was a schedule of construction activities, areas affected, and methods used to control erosion from the sites under construction. This approval was received on February 16, 2006. As USMARC is planning to complete all construction on all sites with equipment and personnel on hand, progress is affected by other farming operations and the weather. At this writing, work is progressing on schedule, and completion is anticipated in October, 2006.

Many lessons were learned through this activity: 1) Permit applications are more than just designing an appropriate runoff control facility, part of the focus of the Project Engineer's research program for many years. While inexperience with the process caused many needless delays, it remained a major task, as does the continued management of the entire facility operation after construction is completed; 2) NDEQ was helpful in providing feedback on questions of interpretation of rules and encouraging the application of alternative control technology; 3) Increasing VTA size can increase runoff when soil infiltration rate is low and rainfall is high. The VTA itself generated runoff. The solution was a relatively small berm to contain the dilute liquid; 4) Site characteristics determine applicability of the technology. When a major drainway was present, no space was available for a VTA, but where gentle slope existed, a settling bench was judged to be adequate; 5) There appeared to be little advantage to providing a relatively large solids settling basin (301-316 VTA and 416-420 VTA), compared to a minimally sized system (404-407 VTA and 408-415 VTA), except where basin overflow would

be detrimental (1100 VTA). Advantages of the larger system might be better nutrient distribution with gated pipe discharge. Research findings should provide some answers.

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Table 1. Summary of design criteria of alternative control technology plus vegetative treatment areas at the USMARC feedlot, sheep pole shed 1, and Area 25 solids storage area.

Location	Feedlot Area (acre)	¹ Design Storm (in)	¹ June Storage (in)	¹ Solids Accumulation (in)	² Rainfall on Basin (in)	² Freeboard (ft)	VTA ³ Length (ft)	VTA Width (ft)	VTA Slope (%)	VTA Area (acre)	VTA ⁴ Ratio (Ac/Ac)
301-316 VTA	6.3	3.9	None	None	5	1.5	1,020	532	0.5	12.6	2.0
404-407 VTA	2.6	1.2	None	0.5	None	None	540	418	0.5	5.2	2.0
408-415 VTA	5.9	1.2	None	0.5	None	None	520	900	0.5	10.8	1.8
416-420 VTA	5.2	3.9	None	0.5	5	1.5	606	743	0.5	10.4	2.0
1100 VTA	1.6	3.9	2.1	0.5	5	1.5	370	375	0.5	3.2	2.0
Pole Shed 1 Bench	3.2	-	-	-	-	-	744	273	0.5	4.5	1.4
Area 25 Solids Bench	1.8	-	-	-	-	-	564	280	0.3	3.6	2.0

¹Volume measure is expressed as equivalent to acre-inches/acre of feedlot

²Volume measure is expressed as units on basin surface

³VTA average length

⁴Ratio is the ratio of feedlot VTA area to feedlot surface area

Table 2. Summary of design criteria of traditional debris basin-holding pond combinations at USMARC feedlot and Area 25.

Location	Feedlot Area (acre)	¹ Design (in)	¹ June Storage (in)	¹ Solids Accumulation (in)	² Rainfall on Basin (in)	² Freeboard (ft)	Status
43A	42.0	3.9	2.1	.5	5	1.5	Proposed
43D	12.0	3.9	2.1	.5	5	>7.0	Existing
Area 25 Beef	11.8	3.9	2.1	.5	5	4.0	Proposed
Area 25 Sheep	13.9	3.9	2.1	.25	5	1.5	Proposed

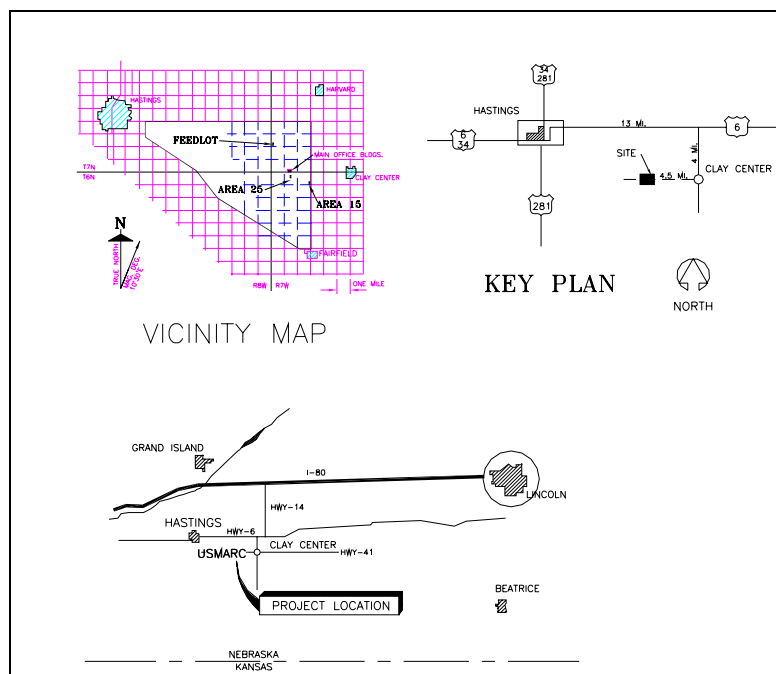


Figure 1. USMARC location map.

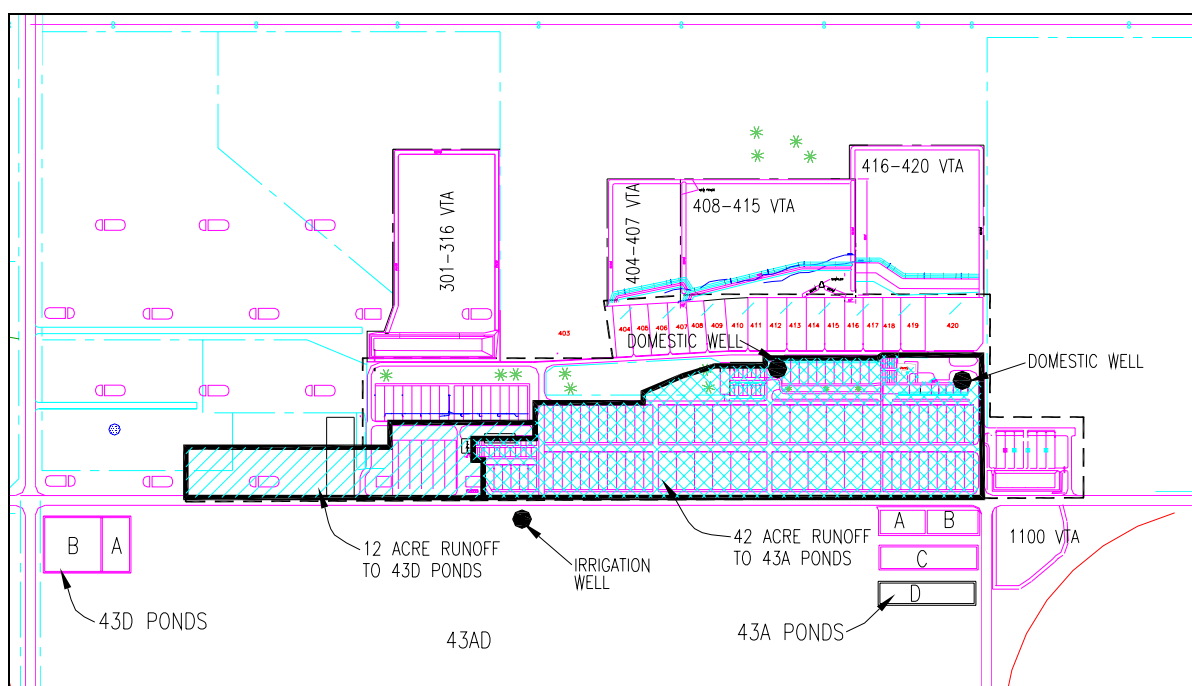


Figure 2. Livestock waste control sites for the USMARC feedlot with five alternative control technology sites; (301-316 VTA; 404-407 VTA; 408-415 VTA; 416-420 VTA; 1100 VTA), and two traditional control technology sites (43A ponds; 43D ponds)

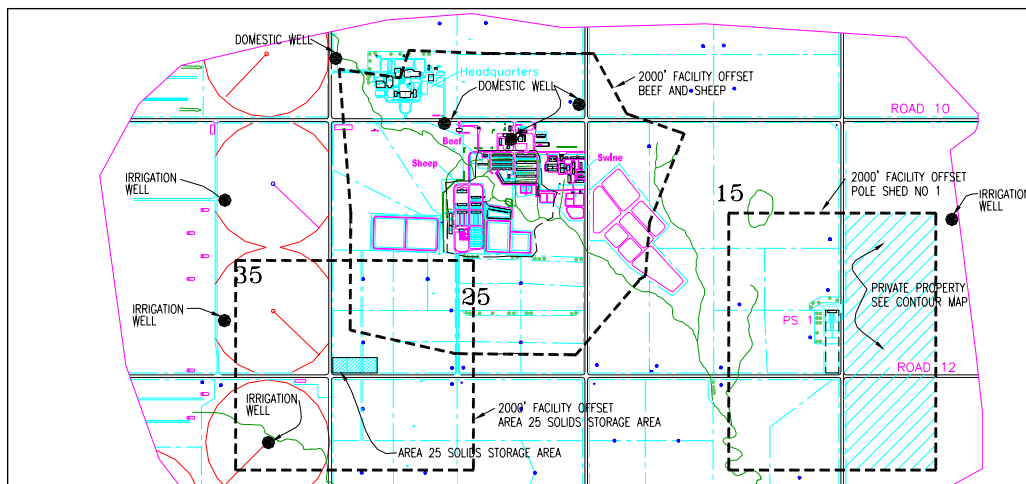


Figure 3. Livestock Waste Control Sites with 610 m (2000') offset lines shown for the USMARC Area 25 (Beef, Sheep and Swine feeding facilities); Area 25 VTA Solids Storage Area; and Pole Shed 1 VTA: Sheep feeding area.

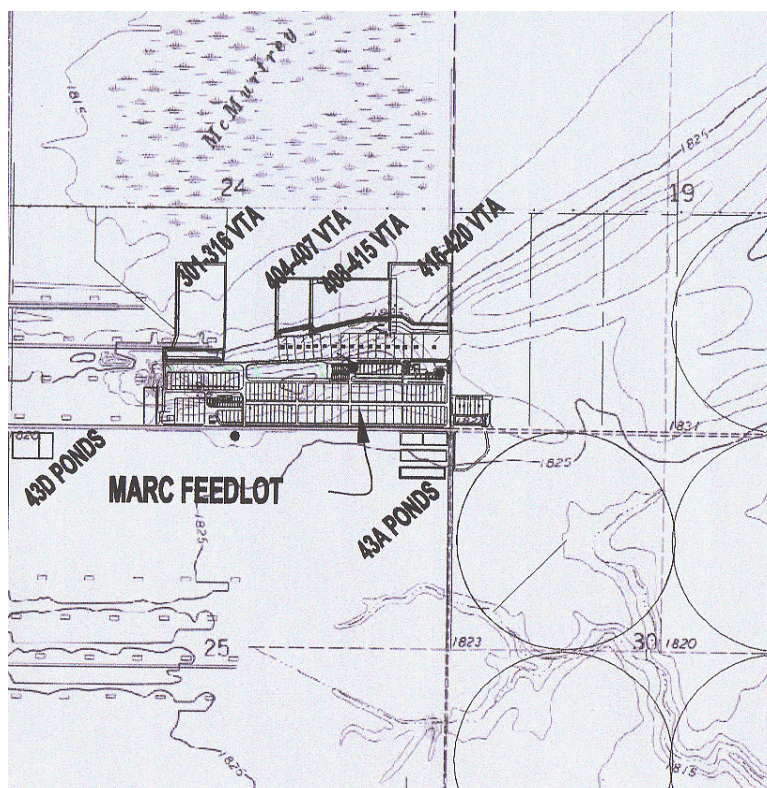


Figure 4. Topographic map of the feedlot area showing each of the five VTA sites at the feedlot as well as the liquid disposal site for 43A and 43D ponds.

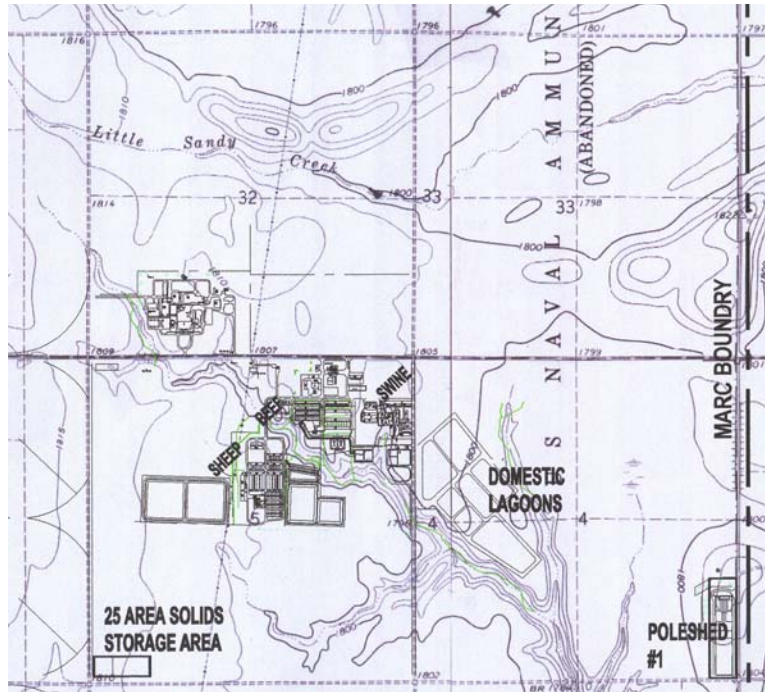


Figure 5. Topographic map of the Area 25 feeding facilities, surrounding cropland and pole shed 1 and solids storage area. The map also shows the primary drainway that divides the sheep feedlot from the beef and swine areas.

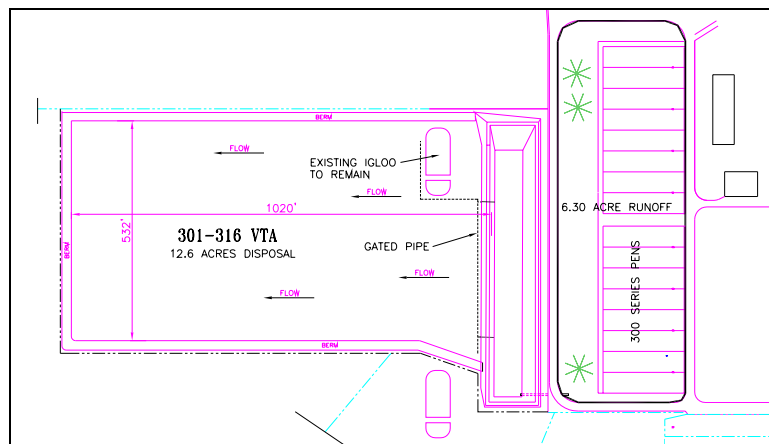


Figure 6. Layout of solids settling basin and VTA for pens 301-316. Discharge pipes are located on opposite ends and connected to gated pipe for even distribution across the VTA. Gates will be alternately used to achieve uniform nutrient loading.

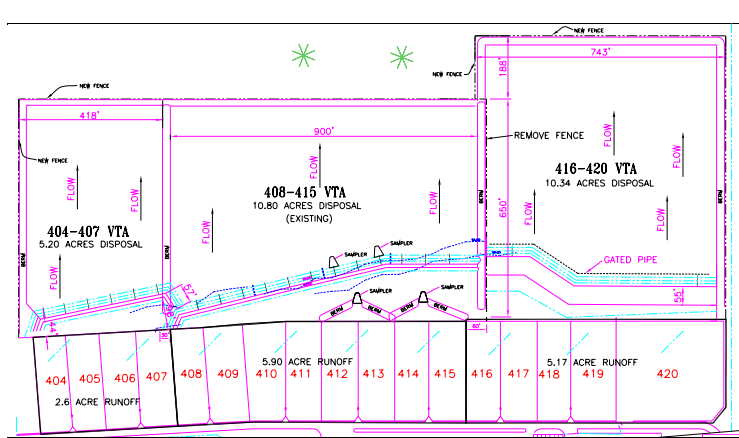


Figure 7. Layout of three VTA systems adjacently located to each other. VTAs 404-407 and 408-415 utilized 200 mm PVC pipe spaced at 21 m to distribute liquid uniformly across the entire VTA width. VTA 416-420 utilized 2-200 mm PVC discharge tubes connected to 250 mm gated pipe to achieve uniform distribution.

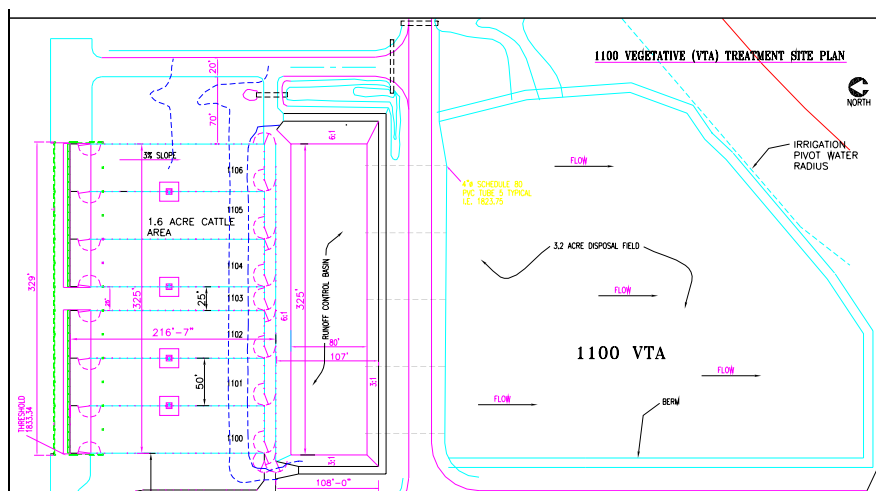


Figure 8. Layout of solids settling basin and VTA for the 1100 series pens. Five 100 mm PVC pipes provide discharge for the VTA physically located across the entrance roadway to the USMARC feedlot.

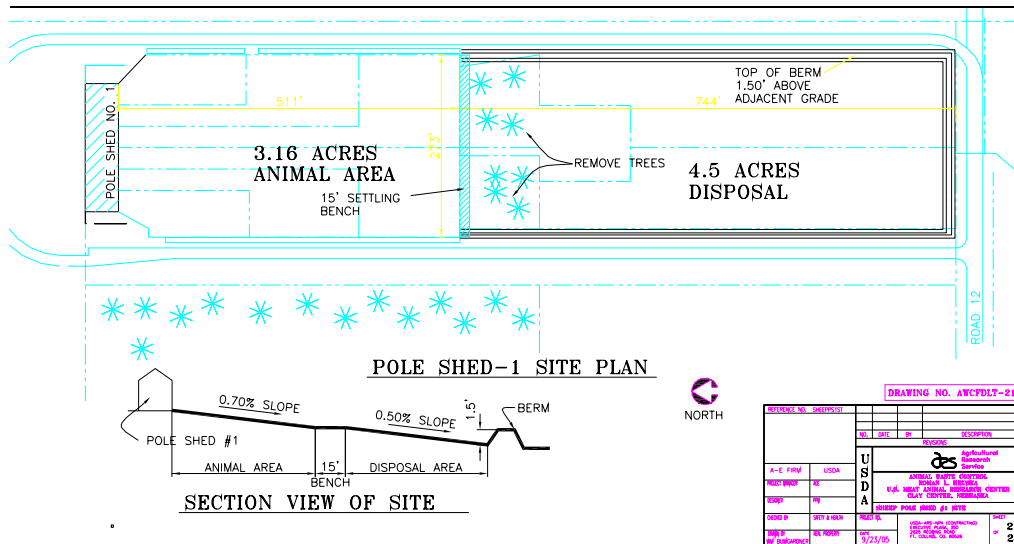


Figure 9. Layout and cross-sectional view of pole shed, feedlot, solids settling bench and VTA. Berm surrounds the entire VTA to prevent any discharge due to a design storm.

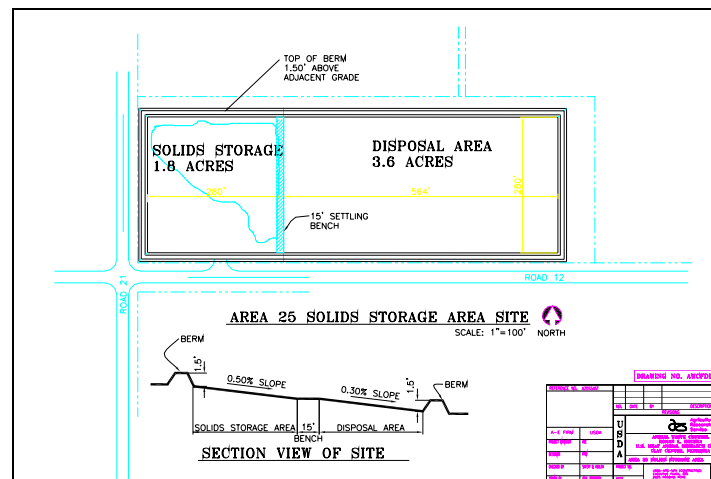


Figure 10. Layout and cross-sectional view of the Area 25 Solids Storage Area and VTA. Cross-section shows the storage area, settling bench, and VTA with a berm that prevents any outside runoff from entering or runoff leaving the site.

